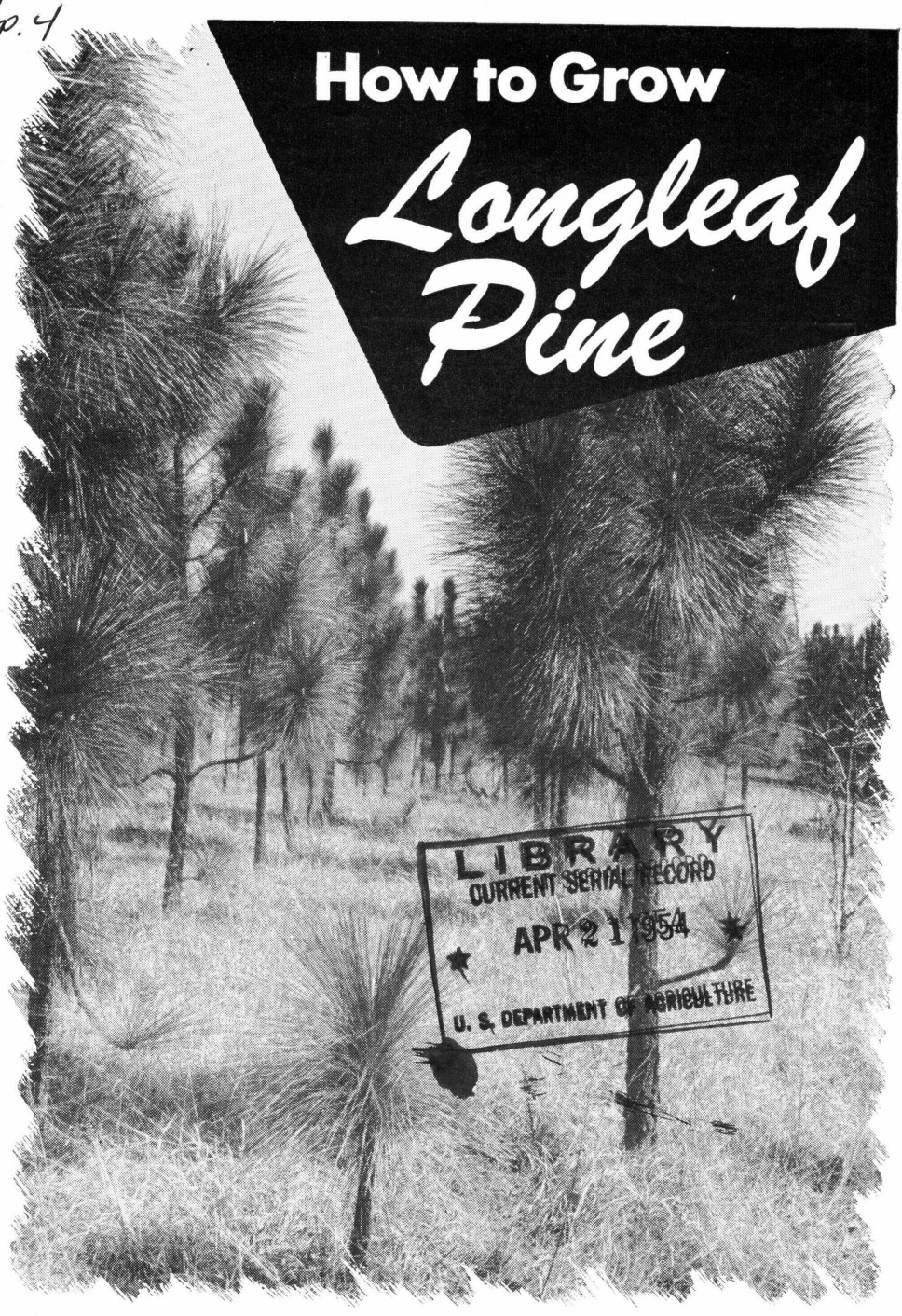
How to Grow Longleaf Pine



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U. S. DEPARTMENT OF AGRICULTURE

LONGLEAF PINE can be profitably grown as a forest crop on farms as well as on large industrial holdings throughout much of the Southern Coastal Plain.

The tree is able to grow well even on poor sandy soils, withstands fires with less injury than other pines, and produces both naval stores and high-grade timber. Furthermore, cattle grazing can be combined with timber production in longleaf forests to enable farmers to make more profitable dual use of their land.

This bulletin offers suggestions to farmers and other timberland owners for establishing and managing longleaf pine. The recommendations are based on the best available knowledge, but are subject to change as further study is made of this unique tree. For additional information and on-the-ground advice, landowners should consult their State Forester or Extension Forester, or other local foresters.

This bulletin supersedes Farmers' Bulletin 1486, *Longleaf Pine Primer.*

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HOW TO GROW LONGLEAF PINE

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WHY GROW LONGLEAF PINE?

Longleaf pine is a tree of many uses and high value. It has long been and continues to be in great demand for sawlogs, poles, piling, pulpwood, and naval stores. Such a variety of products and good markets helps make it a profitable tree to grow.

Longleaf is more resistant than other southern pines to fire, insects, and such diseases as littleleaf and fusiform rust. In fact, where land cannot be continuously protected from fire, longleaf may be the only species that has a chance of success. Another important advantage is its ability to grow better than other species on the drier sites, including deep sandy soils. But regardless of site, where longleaf pine is already growing on the land, either as trees bearing seeds or as young growth, it will pay the owner to protect and manage this longleaf as a crop.

Natural conditions and management practices in the longleaf type are generally more favorable for cattle grazing than in other southern pine types. Under certain circumstances, this makes it possible to use the forest land to produce both timber and cattle.

Some objections to growing longleaf pine include the damage that can be done by hogs and the brown-spot needle disease, the difficulty of establishing new stands, and longleaf's slow early growth and resultant late returns. Proper management can partly overcome many of these objections. On the better soils of the Coastal Plain, however, loblolly pine or slash pine may survive and grow better, and should probably be preferred to longleaf.

TREE CHARACTERISTICS

Longleaf pine is a unique tree. Its needles usually are 8 to 12 inches long and sometimes reach 18 inches—longest of all pines. They grow three in a bundle borne in a sheath, and form dense tufts at the branch ends on older trees. The twigs are thick and sturdy. On young trees

the bark is gray and deeply furrowed; on older trees the furrows become shallower and the bark is orange brown. As the trees decline with age, the bark becomes lighter and the outer scales appear more numerous and papery.

The seeds and cones are larger than those of other southern pines. Seeding is very irregular and heavy crops are produced only intermittently. The seed is shed in the fall, mostly in November, and germinates usually within 2 or 3 weeks.

For the first 6 months after it germinates, the longleaf seedling is most vulnerable to fire and drought. It then develops secondary foliage and looks like grass (fig. 1). In this "grass" stage, which lasts 2 to 10 years, it is fairly resistant to fires and drought. Once height

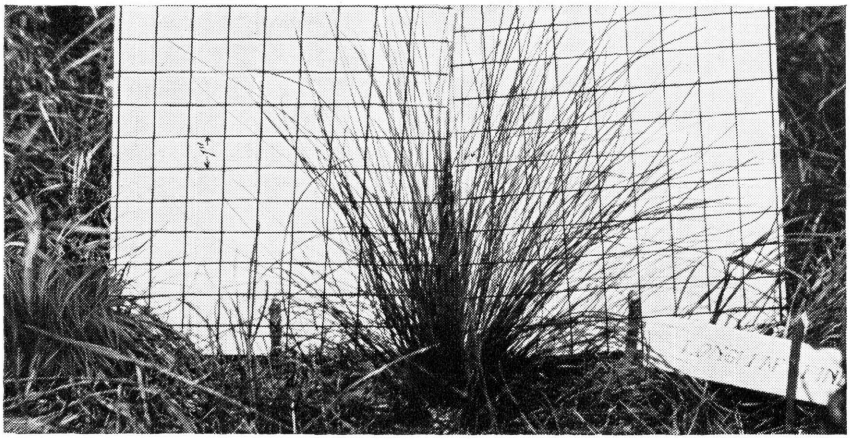

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FIGURE 1.—Longleaf pine seedling in the grass stage of development. In this stage, longleaf seedlings are fairly resistant to fire. (Background: 1-inch squares.)

growth commences, however, the seedling is again very liable to damage from fire, and remains so for 3 or 4 years, or until it is 8 or 10 feet tall.

Seedlings do not always progress this rapidly. Often their grass stage is prolonged by poor soil, by competition from grass, brush, or other trees, or by injury from fire, animals, or disease. Many backward seedlings become deformed, have abnormal buds and scant foliage, and yet cling persistently to a feeble existence. Stunted seedlings are capable of recovery as soon as the causes of retardation are removed, but they never emerge from the grass stage until the roots are large enough or the stems at least 1 inch thick at ground level. Because of this growth characteristic, the trees in a young longleaf stand have very irregular height, even though all of them may be the same age (fig. 2).

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FIGURE 2.—Typical young longleaf pine. Although the trees are all of the same age, some have reached sapling size while others are still in the grass. The two seedlings (right foreground) that have just begun height growth are susceptible to fire. The taller saplings are more resistant.

In other southern pines, most seedling deaths take place in the first year. Longleaf seedling losses, however, are spread out over a longer period.

A fungus causing the brown-spot needle disease is usually found on longleaf in the grass stage, especially on unburned areas. The disease causes severe defoliation, is often fatal to seedlings less than 18 inches tall, and seriously retards others up to 3 or occasionally 5 feet tall.

The first symptom of brown spot is a small, light, gray-green circular spot which changes quickly to brown and later encircles the needle in a narrow band. Death of the end portion of the needle results from multiple infections rather than an isolated girdling lesion. As scattered lesions increase, they divide the long needles into three zones of infection: (1) The green basal part of young needle tissue nearly free from spots, (2) a spotted middle section where lesions alternate with green tissue, and (3) an outer brown zone of older dead tissue.

HOW TO ESTABLISH A STAND

Establishing a crop of actively growing seedlings is probably the most difficult task in growing longleaf pine. It can be accomplished, however, by persistence and care. Where enough seed trees are present, it is best to rely on them. In other places a stand may be established by planting 1-year-old seedlings or by sowing seed. Whichever method is chosen, the task of starting a crop and carrying it through the early years can be accomplished best by the use of fire under prescribed conditions, commonly called prescribed burning.

Although fire has been and still is an enemy of longleaf pine, its planned and proper use is necessary if this tree is to be profitably grown for crop after crop. If fire is kept out permanently, longleaf land will eventually revert to other pines and hardwoods. As will be explained later in more detail, prescribed burning serves four chief purposes. It helps prepare the site for planting or seeding, it is valuable in controlling the brown-spot needle disease in young seedlings, it reduces the hazard from wildfire, and it helps to kill or set back the hardwoods that might otherwise interfere with the longleaf.

Acceptance of prescribed burning, however, does not mean that one condones indiscriminate burning. There is absolutely no place for wildfire in growing longleaf or any other species. Uncontrolled fire or incorrect burning kills many trees and reduces the growth of others by scorching them. Prescribed burning should be used only with the advice and assistance of local forest agencies. It should be restricted to flat or gently rolling land. On steep land repeated burning may cause erosion and damage to the watershed; other species than longleaf should probably be grown on such sites.

Natural Reproduction

In a good seed year, enough seed for a new crop of trees can be obtained from as few as four well-distributed seed trees per acre if each tree is a good producer, seedbed conditions are ideal, and predators are scarce. Since such ideal conditions seldom occur, it is better to have more seed trees. If one plans to leave seed trees after a harvest cutting, 12 well-distributed trees at least 10 inches in diameter should

be left per acre (fig. 3). If equally spaced, the trees would be 60 feet apart. This number will insure more than enough seed in a good year and may be adequate even in off years if other conditions are favorable. This number also makes it profitable enough to come back for a seed-tree removal cut.

A good seed bearer can be positively identified only by its past performance, as indicated by the presence of numerous old cones in the tree or on the ground. But where past performance is unknown, trees to be left for seed should be healthy and well formed, and their crowns preferably should be dense and long (at least one-third of the total length of the tree).

Longleaf seed germinates and grows best on bare mineral soil. On areas that have not burned for several years, grass, weeds, and other litter accumulate. This mat of vegetation or *rough* hinders the seed from reaching bare soil, and may smother or retard the growth of some seedlings that do get started. The rough also harbors numerous rodents that eat seed. Removal of the rough thus improves germination and early growth of the seedlings. The better the seedbed, the better the catch of seedlings.

A good seedbed is most efficiently prepared by burning off the rough. A fresh burn, made in September or October (before seed fall) when conditions are suitable for burning, is recommended. However, where palmetto and gallberry make up most of the fuel, prescribed burning can be done safely only from December 1 to February 15.

A cool windy day within a few days after a rain, when the soil is still moist but the rough capable of burning, is generally a good time.

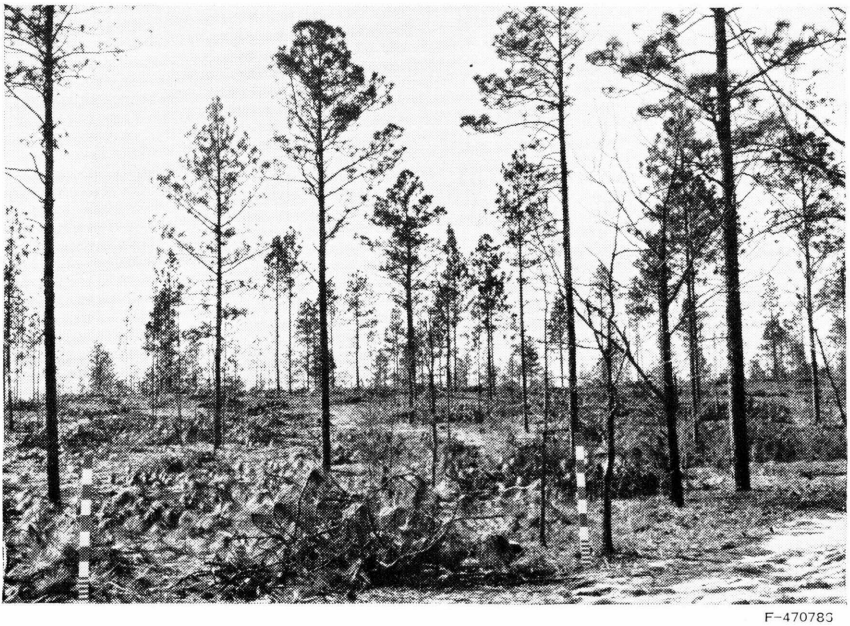

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FIGURE 3.—When longleaf pine is harvested, 12 good seed trees should be left on each acre. They should be cut as soon as a new crop of seedlings is established.

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Firebreaks should first be plowed around the area except where natural barriers like roads or creeks can be used. For burns of several hundred acres or more, the area should be broken into several blocks by cross-breaks.

Usually the fire should be set against the wind (backfire) because then it can be controlled better and is less likely to damage the seed trees or seedlings making height growth. If the rough is so wet or green that the fire does not burn well against the wind, it may be burned with the wind. A head fire (with the wind) usually burns faster and hotter and scorches to a greater height than a backfire. If numerous hardwoods and few pine are present, a hot fire should be used to kill as many of the hardwoods as possible.

A 1-year-old rough also makes a satisfactory seedbed and must be relied on where burning immediately before seed fall is unsafe. The grass on a 1-year rough is light enough to permit the seed to reach bare soil and at the same time offers some protection for the seed against birds. However, if the seedbed is to be prepared to take advantage of a heavy seed crop, it is necessary to predict such crops (by counting the cones) 1 year in advance. Longleaf cones take 2 years to mature, and at the end of the first year they are so small that they are almost impossible to see from the ground; many of them also fall victim to disease, insects, or unfavorable weather in the second year. Therefore, it is much easier and more certain to appraise the crops just before seed fall, when the cones are 2 years old.

A good seedbed can also be prepared by disking instead of burning. In fact, disking may even be preferable if done thoroughly. Seedlings live and grow better on a disked site than on a burned one, particularly when a drought year follows seeding. Even though disking is much more costly than burning, especially over large areas, it may be practicable for small tracts such as farm woodlands.

The seedling catch can best be judged 1 year after seed fall, when the seedlings are through the critical first summer. A good catch is at least 2,000 per acre, fairly evenly distributed over the area.

The next step is to get these young seedlings to start height growth as quickly as possible. Seed trees compete with the seedlings, and can prevent their early growth and development. They should be removed as soon as serious competition becomes apparent, usually when the seedlings are at least 2 years old and there are 1,500 or more of them per acre. It is important, however, that the new crop be protected from hogs, brown spot, and wildfire.

Where brown-spot disease is prevalent, prescribed burning will again be beneficial. Burning will also reduce competition from other vegetation. Generally, it will be desirable to burn in the second or third year after seeding, and again in about the fifth year just before most seedlings are ready to start height growth. The actual interval will depend upon how heavily the seedlings are infected and how fast they are developing. Burning to promote better height growth should be done in the winter on cool days after some rain and when the wind is steady. A fast-burning backfire is best.

Seedlings under hardwoods will not survive or grow well. The overtopping hardwoods should be deadened as soon as possible. Since hardwoods larger than about 2 inches in diameter usually are not

killed by prescribed burning, other controls must be used. Chemical tree killers are best for killing undesirable trees and brush since they minimize sprouting. For this purpose, ammonium sulfamate (trade name Ammate) and 2,4,5–T are both very effective and safe to use. Information on their use can be obtained from local foresters. Effective release can also be had by girdling the hardwoods. The smaller ones may sprout profusely, but the sprouts can be controlled by periodic burning after the longleaf seedlings are at least 2 years old.

Planting

Longleaf pines can be planted by using 1-year-old nursery-grown seedlings, preferably from seed collected in the locality of the planting site (fig. 4). Seedlings can usually be obtained at about the cost of production from the State Forester, who will also give instruction on their care and planting. Planting stock should be ordered early, in late spring or early summer, to insure filling orders. The best months for planting are December, January, and February.

Most planting sites should be prescribe-burned before planting. Burning makes planting easier, reduces competition from grass and brush, and protects the planted seedlings for a while against brown-spot infection from natural seedlings.

Seedlings must be kept moist and sheltered all the time between lifting and planting. The sooner they are planted, the better. However, they can usually be kept safely for a week or two by heeling them into light loamy or sandy soil. To heel in planting stock, dig a trench about 3 inches deeper than the length of the roots and with one side sloping a little. Pack the stock against the sloping side in a layer 3 to 5 inches thick with roots unbent and tops sticking up,

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FIGURE 4.—*A*, Successful longleaf plantation 5 years after planting. *B*, Same plantation at 18 years.

and cover the roots with firmly packed earth. Then water the stock in the heel-in bed often enough to keep the soil continuously moist.

Seedlings should be planted at a spacing of 5 by 6 feet, or about 1,450 trees per acre. This spacing is closer than that recommended for other southern pines, but is desirable because of the higher mortality and more irregular height growth of longleaf. Only about 35 to 40 percent of the planted trees can be expected to grow to merchantable size. This will make a stand of about 500 trees per acre at the time a first thinning will be needed, at about 25 years. In many instances survival and growth have not been this good, but usually the trouble has been poor management.

Seedlings can be planted successfully with almost any tool that will open a hole large enough for the root system and then close the soil firmly about the roots. A favorite tool is the planting bar illustrated in figure 5. Such a bar can be bought from various tool companies or made by a blacksmith.

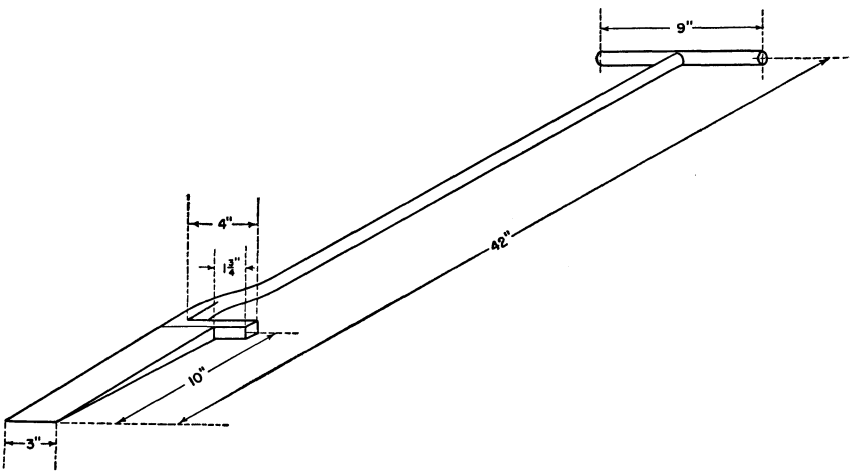

FIGURE 5.—Planting bar.

Each tree is planted in a slit made by the blade, and this first slit is closed by a second about 4 inches behind it. The second slit in turn is closed by the planter's heel. Men work either singly or in pairs, preferably singly.

Other tools in common use are mattocks, grub hoes, and several kinds of shovels. Pails, trays, or baskets of some kind are needed for carrying seedlings and for keeping their roots moist during the planting.

Longleaf can also be planted by machine (fig. 6). Several types of tree-planting machines have been developed and are frequently made available to farmers and other landowners by various local agencies and groups interested in reforestation. Two men with a planting machine can set out 9,000 seedlings in a day. One man, without a machine, can plant only about 1,000. If properly done, machine planting gives as good results as hand planting.

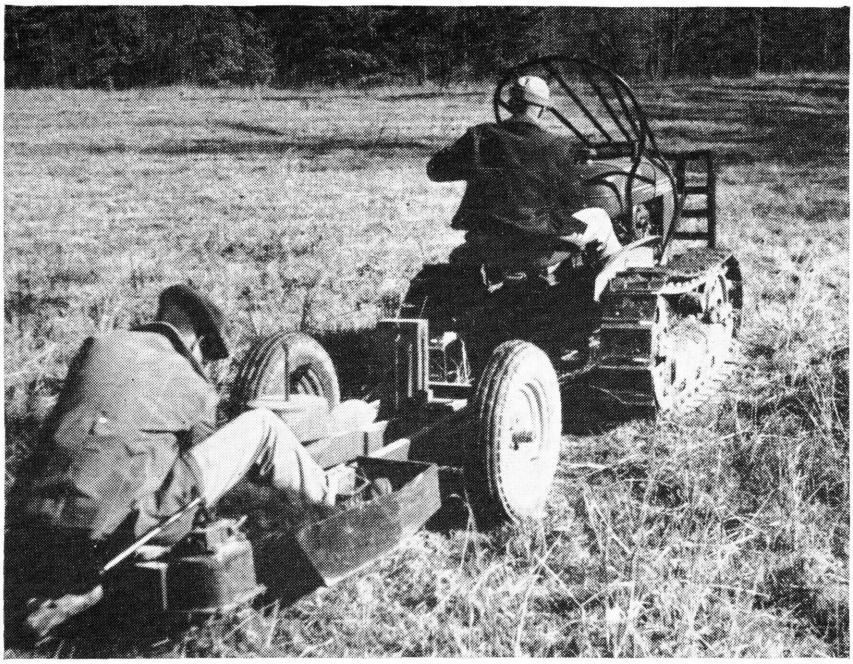

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FIGURE 6.—With a planting machine, 2 men can plant pine on cutover land at the rate of 1,000 or more trees per hour.

Landowners may also have their planting done by contract. Planting service is available from many consulting foresters.

In planting, the important things are: (1) To keep the roots moist; (2) to avoid skinning or breaking them; (3) to get them straight and well-spread in the slit or hole; (4) to keep leaves and other trash out of the hole; (5) to set the tree the same depth in the ground that it grew in the seedbed; and (6) to close the earth firmly about the roots.

Longleaf can be successfully planted under hardwoods provided the hardwoods are deadened soon after planting. The hardwoods can be either girdled or treated with chemicals, as was previously recommended for hardwoods interfering with natural seedlings. Care of plantations through the grass stage, including prescribed burning, is also similar to that recommended for natural reproduction.

Direct Seeding

Longleaf may be established by sowing seed, though this method is less reliable than planting seedlings. The principal causes of failure are birds, rodents, and drought. Direct seeding can, however, supplement natural seeding on areas where the seed supply is sparse and whenever planting stock is unavailable. In bountiful seed years, ample supplies of local seed can be obtained to seed large areas quickly and cheaply. Direct seeding does not require big labor crews nor as much advance planning as is needed for planting large areas. It may also be cheaper than planting when properly done.

Direct seeding is still in an experimental stage. Thus far the best results have been obtained by the following procedure:

1. Burn or disk before seeding. This controls mice and other seed-eating rodents by disturbing the ground cover, and also helps germination and rooting. Disking is more costly than burning, but is more likely to secure a good stand, particularly in a dry year following seeding.

2. Seed preferably in November and not later than mid-December, after a good rain. The weather will be warm and moisture usually adequate for prompt germination. Seedlings established in the fall are better able to survive the first year.

3. Sow fresh seed of good quality at a rate of 3 pounds (15,000 seeds) per acre. If poor seed has to be used, sow proportionately more.

4. Sow seed broadcast. This is more efficient and cheaper than drill or spot seeding. On small areas, sowing may be done with hand seeders commonly used on the farm. On large areas, it can be done most efficiently by airplane. Commercial flying services equipped to dust cotton and sow farm crops can sow longleaf seed satisfactorily and at a reasonable cost. However, close cooperation between the pilot and ground supervisor is necessary to insure good distribution of the seed.

5. Protect the seed. Frequent inspections should be made after seeding. At the first sign of serious damage from concentrations of doves, meadowlarks, and particularly blackbirds, a diligent and intensive patrol should be set up. The patrol is simply a man with a gun, used to scare the birds rather than kill them. The patrol will be needed for about 4 weeks, by which time germination is usually completed and most of the seed coats have been shed. Sometimes grasshoppers, caterpillars, and other leaf-eating insects seriously damage the seed before and during germination. Under special conditions benzene hexachloride or chlordane dust or sprays might be used to control them.

Protection

Control of wildfire and woods hogs is necessary to success in establishing the longleaf crop, whether it is natural, planted, or direct-seeded. A farmer should supplement the fire protection provided by the State. He can plow a fireline around the area, be careful when burning off grass and brush, use his influence with his neighbors to see that they do not let fires get away, and cooperate with the State by helping to detect and extinguish fires.

Woods hogs are outstanding enemies of longleaf seed and seedlings, and must be excluded (fig. 7). This requires proper fencing in areas where hogs are numerous and range at large (fig. 8). Sheep and goats also injure seedlings and should likewise be kept out.

Cattle need not be excluded, but they should be restricted. They are most harmful in the first year, when seedlings are least resistant. Areas burned just before seeding or planting are especially vulnerable because cattle concentrate on fresh burns. After the first year, moderate grazing may be permitted if the cattle are properly managed (see pp. 23 to 25).

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FIGURE 7.—This young longleaf was destroyed by hogs. Hogs girdle or uproot seedlings to eat the thick, succulent root bark, and can completely eliminate young longleaf over large areas.

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FIGURE 8.—The hog fence made the difference between the good stand of longleaf on the right and the bare area to the left.

The most serious disease of longleaf seedlings is brown spot, previously described on page 4. Periodic prescribed burning, preferably in the winter, is recommended for control of the disease. Fungicidal sprays are also effective, but much more costly than burning.

In some localities, black ants and leaf-cutting red or "town" ants destroy sprouting seeds and young seedlings. Town ants can be controlled by pouring either methyl bromide or 2 percent chlordane in water emulsion into the holes of the colonies. When a thermal fog generator is available, fogging the anthill with DDT or DDT-plus-chlordane gives excellent results.

HOW TO MANAGE THE STAND

A stand may be considered established and well stocked when there are 500 or more well-distributed trees at least 8 feet tall per acre. Thereafter, until thinnings become necessary, it requires only continued protection against wildfire and hogs. Prescribed burning in the winter at intervals of about 5 years may be desirable to help keep hardwoods under control and to reduce the hazard from wildfire, but is not essential for good growth and development of the longleaf.

For maximum profits, the stand should be managed for a combination of wood products, usually with high-grade sawlogs as the principal product. Cuttings should be made at regular intervals, and the trees utilized for those products that yield the greatest profit. Ordinarily trees large enough and otherwise suitable should be cut for sawlogs, poles, or piles. The smaller trees and tops are used for posts or pulpwood. In some localities, trees that are soon to be cut may first be worked for naval stores.

Thinning

Thinning is the process of removing surplus or weak trees. Thinnings are made in crowded stands to concentrate growth on selected trees, to salvage merchantable trees that would otherwise die from overcrowding, and to produce early and regular income (fig. 9). They should start at an early age, but not before the trees selected for removal are large enough to pay for the operation.

In natural stands, the first thinning is generally advisable when the trees are of pulpwood size and most of the best ones have lower branches dead for at least one and preferably two log lengths, provided that crowns of crop trees (the ones to be kept for final harvest) have not been excessively reduced by this time. A crown length of 35 to 40 percent of the tree's total height is necessary for good growth.

In most stands, thinnings can and should be started at about 25 years of age. They should be repeated about every 5 years, and should be heavy enough to maintain a crown length of 35 to 40 percent in the crop trees.

Dense stands (more than 500 trees per acre) should be thinned by removing the small, slow-growing trees and keeping the large, better ones. Crooked, diseased, and injured trees should likewise be removed. The thinning should be heavy enough to open the main crown canopy. The first step in accomplishing this is to remove the large (dominant) trees that are excessively limby. In dense stands,

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FIGURE 9.—This longleaf stand, now about 30 years old, was lightly thinned 4 years ago for posts. It is about ready for a second thinning, which will yield poles, posts, and pulpwood.

however, this will rarely open the canopy enough, and it will generally be necessary to cut many of the medium-sized (codominant) stems as well. Trees too small to be merchantable should be left standing, because they have little effect on the growth of the larger trees and may later grow into merchantable size. A first thinning in a dense stand generally should remove about one-third the volume and one-half the number of merchantable trees. These thinning recommendations apply particularly where the aim is to grow as much timber as possible. If early production of naval stores is desired, thinnings should be earlier and heavier.

In overdense stands (more than 900 trees per acre), not enough trees may reach pulpwood size at 25 years. Therefore, it may be necessary to delay thinning.

Understocked stands most often need improvement by cutting large rough trees that are interfering with smaller trees of better quality. Thinning is necessary only where the trees are in dense groups.

In planted stands, 500 trees per acre would represent good stocking at 25 years of age. The trees will average about 7 inches in diameter, and crop trees will have lower branches dead for about 2 log lengths (32 feet) without excessive shortening of the live crown. The first thinning should leave about 300 of the best trees, and a second thinning 5 years later should reduce this to about 200 well-spaced trees. If it is desired to have 40 crop trees per acre for harvest at age 80,

then 160 trees are available for cutting between the time of the second thinning and the final harvest. This number provides an average of 18 trees per cut if thinnings are made every 5 years or 40 trees per cut if every 10 years. The number of trees removed will be greater than 18 in the early cuts and less in the later ones, but the volume of wood removed in each cut might remain about the same.

Pruning

Pruning is recommended for the more open-grown trees commonly found in longleaf pine stands. Such trees will never produce high-grade timber unless they are pruned, and the earlier the better. In well-stocked stands, the trees will prune themselves satisfactorily by natural means, so that artificial pruning usually is not needed.

Pruning should begin in the sapling stage. If delayed too long, costs increase and benefits decrease. Limbs should be cut close to the trunk, so as to leave no stubs. Up to 200 selected trees per acre should be pruned when they are not more than 3 to 4 inches in diameter and have limbs less than 1 inch thick.

If the trees are 5 or more inches in diameter, however, and the stand contains more than 150 trees per acre, only 100 to 150 selected stems per acre should be pruned. At this stage crop trees can be chosen with enough certainty to avoid the expense of pruning many trees that will have to be removed before the final harvest.

Since pruning handicaps a crop tree in competing with its unpruned neighbors, all unpruned trees should be removed as soon as practical. This will ensure the most rapid growth on pruned crop trees and at the same time will bring in revenue to help defray the cost of pruning.

Pruning to a height of 17 feet to clear one 16-foot log is most profitable (fig. 10). Higher pruning costs more and yields less benefit. The 1-log length may be pruned in either 1 or 2 operations, depending on the height of the trees. If the trees are at least 30 feet tall, one operation is recommended. If the trees are smaller, two operations should be made. The first one should prune not more than 60 percent of the total height of the tree, since removing more than this usually reduces the live crown so much that growth is lost. When the trees are about 30 feet tall, the pruned length can be extended to 17 feet.

Pruning may be done at any season, although winter is the most efficient time for woods work. Pruning during severe drought may induce insect attacks.

Saws are the recommended tools for pruning. A hand saw with coarse incurved teeth is best for pruning up to 7 or 8 feet. A pole saw should be used for heights up to 17 feet. Pole saws should have narrow, curved, rigid blades, about 16 to 18 inches long, with 5 to 7 teeth per inch, filed to cut on the pull stroke. The handle should be 10 to 12 feet long, made up of 1 or 2 sections of wood or preferably aluminum.

Longleaf pine can be pruned at very low cost. In a recent large-scale experiment, 100 open-grown longleaf trees per acre (averaging 5 inches in diameter) were pruned to a height of 17 feet with a pruning saw mounted on a sectional aluminum pole. Labor, including time for walking and delay, averaged 5⅓ man-hours per acre. At current labor rates, this is approximately 5 cents per tree.

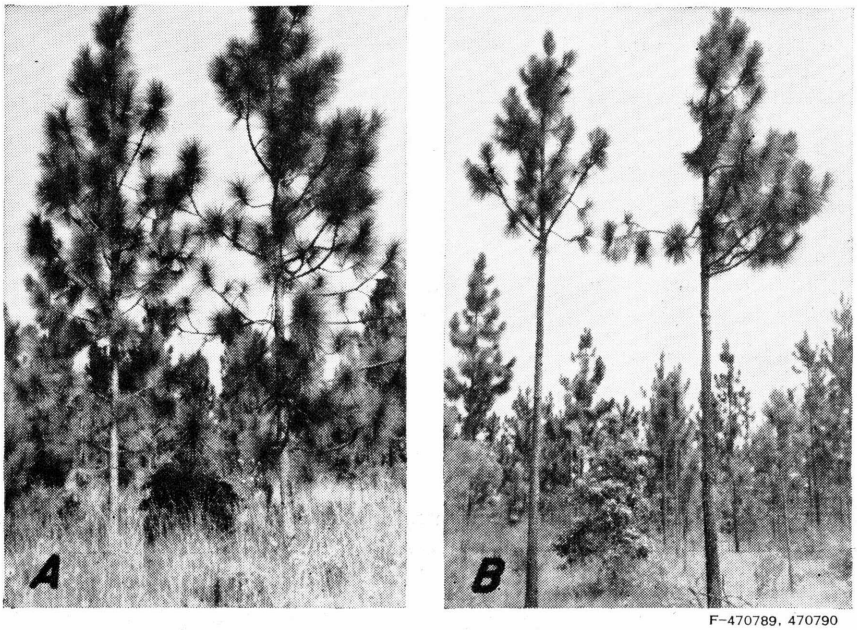

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FIGURE 10.—*A*, Open-grown longleaf pines are limby and should be pruned when small if they are to produce high-grade timber. *B*, Same 2 trees after being pruned to 17 feet.

Harvest Cutting

Cuttings to thin the stand and take out damaged or injured trees should continue until the final harvest. The size and value of the trees removed will increase with each successive cut. Sawlogs should be possible after the second or third thinning, with poles, piles, and pulpwood also available. If managed properly since youth, trees on average sites are expected to be about 20 inches in diameter when they are 80 years old. At this size, it is not only good forestry but probably most profitable to harvest them and start over again with a new crop. Of course, some owners may have good reasons for carrying their stands for longer or shorter periods.

Longleaf grows best unmixed with other species and in stands in which all trees are the same age (even-aged). A final harvest should therefore be made in a manner that will produce such stands. Clear-cutting but leaving seed trees will best accomplish this. The procedure recommended on page 4 for securing natural reproduction should be followed.

Where second-growth longleaf forests are being placed under management for the first time, harvest cuttings as described above may need to be modified. Many of these forests are understocked and patchy, with individual trees varying greatly in age or height. The trees in such stands may continue to grow well, but they cannot make full use of all the growing space. Additional trees needed to build

up the stocking are difficult to secure, particularly in openings larger than 1 acre. The aim of management should therefore be gradual conversion to fully stocked, even-aged forests or extensive stands.

Old-growth seed trees, if there are any, should be cut as soon as a new seedling crop is established and can be protected from hogs, brown spot, and wildfire. These old trees generally grow slowly, and are better replaced with young ones. Second-growth pines of all sizes should be kept. If large enough, they will help seed the area. Openings too large to be seeded in from trees should be planted or direct-seeded.

The resulting stand will be fairly well stocked, though it may have groups differing by as much as 40 years in age or size. When the final harvest is made, the youngest will not be quite mature (though usable) and the oldest may be slightly overmature; but if enough seed trees are left, the succeeding stand will be largely even-aged.

Bark Beetles

Southern pine beetles, Ips engraver beetles, and black turpentine beetles can cause serious damage in longleaf stands. Trees weakened by drought or fires, or in or near stands that have been recently cut, are most susceptible to attack. Keeping the stand in a healthy growing condition by good management will help prevent attacks by these insects.

Insect attack should be suspected whenever the needles of the pines turn color. Other signs are small holes and pitch tubes on the trunk and frass (fine, sawdustlike insect excrement) on the bark or at the base of the tree.

When an infestation does start, the broods developing in the bark of the trees should be destroyed to prevent them from emerging as beetles to attack other trees. Control measures should be applied immediately, while the needles of the infested trees are pale greenish yellow. By the time the needles have turned dark brown, the beetles have usually left the tree.

Infested trees should be harvested and utilized as quickly as possible. The slabs or bark should be burned at the sawmill or woodyard to prevent the beetle broods from emerging. If immediate harvesting is not practicable, infested trees should be felled and barked, and the bark and tops piled and burned. Spraying the trunks and stumps of infested trees that have been felled but not barked also helps to prevent new attacks and to control existing beetle populations. A good spray is 0.25 percent gamma benzene hexachloride in number 2 fuel oil. Spraying lightly infested living trees with this material will aid in preventing further attack—especially by the black turpentine beetle.

Growth and Yields

No longleaf stands have been under management long enough to show exactly how much wood will be produced from seed till final harvest. However, there are indications that well-stocked stands, if properly managed, may produce in 70 to 80 years the volume of timber found in virgin stands 200 years old.

In south Mississippi, growth measurements were made for 42 years in a well-stocked stand. The average rate of growth during this time, as table 1 shows, was more than a cord of wood per acre each year.

TABLE 1.—*Average size and yield per acre for second-growth longleaf pine in south Mississippi*

Age of trees (years)	All trees	Height of trees	Diameter of trees (breast high)	Basal area [1]	Volume in trees—	
					4 inches and over in diameter	9 inches and over in diameter
	Number	*Feet*	*Inches*	*Square feet*	*Rough cords*	*Board feet* [2]
13	918	24	4. 2	13	1. 1	
18	643	37	4. 8	44	6. 3	
23	617	47	5. 6	71	14. 6	
28	536	56	6. 2	88	22. 5	
37	438	70	7. 3	117	40. 4	8, 470
42	379	75	8. 9	[3] 128	[3] 49. 2	[3] 11, 990

[1] Cross-sectional area, including bark, of trees at 4½ feet above ground. For example, a 13½-inch tree has a basal area of 1 square foot.

[2] International rule, ¼-inch kerf.

[3] Includes material removed as thinnings in 37th year.

The stand was burned at least twice by wildfire after establishment, and probably several times during the seedling stage. No thinnings were made until the 37th year, at which time the stand averaged 8,470 board feet per acre. With earlier thinning and better protection against wildfire the trees would have grown even better. At 42 years the total volume, including thinnings, was nearly 12,000 board feet.

If thinnings are continued, growth for the next 30 years should average 400 board feet per acre per year. The 40 best crop trees are expected to grow 2½ inches in diameter every 10 years, though slower growing noncrop trees (included in the averages in table 1) will not do this well. At this rate, the total yield at 80 years should be about 27,000 board feet per acre. (These volumes are in the International log rule, ¼-inch kerf. The International rule more closely approximates the actual lumber tally obtained by sawing a sound, straight log than does the commonly used Doyle rule, which usually underestimates sawed volume badly.)

In a longleaf plantation in southwest Louisiana, trees averaged 66 feet in height and 10.5 inches in diameter at breast height when they were 40 years old. The volume per acre was 3,550 cubic feet, equal to 46 cords of rough wood. Additional wood had been removed in two earlier thinnings for posts and poles.

Growth possibilities are also indicated in table 2, which predicts the development of the dominant and codominant trees—the ones in the main crown canopy. The table was estimated from measurements made in thick, uncut stands that had been burned over repeatedly by

TABLE 2.—*Average number, size, basal area, and volume per acre of dominant and codominant longleaf pines at various ages in fully stocked unmanaged stands on average site (site index 70)*[1]

Age of trees (years)	Average height	Average diameter at breast height	Trees	Basal area	Merchantable volume [2]	
					Pulpwood	Sawlogs
	Feet	*Inches*	*Number*	*Square feet*	*Rough cords*	*Board feet*
15	26	3.8	605	48	7	200
20	36	5.1	525	66	13	900
25	45	6.0	435	76	18	2,700
30	52	6.8	370	84	23	5,000
35	57	7.6	320	91	27	7,200
40	62	8.2	285	97	31	9,500
45	66	8.8	265	102	34	11,800
50	70	9.3	245	107	38	14,500
55	74	9.8	230	111	42	16,300
60	77	10.2	215	114	44	18,600
65	79	10.6	205	117	47	20,400
70	82	11.0	195	120	50	22,200
75	84	11.3	185	122	53	24,000
80	86	11.7	180	124	54	25,300

[1] Derived from tables 65 and 91–95 of *Volume, Yield, and Stand Tables for Second-Growth Southern Pines.* U. S. Dept. Agr. Misc. Pub. 50, 202 pp. 1929. (Out of print, may be consulted in libraries.)

[2] Utilization assumed to a fixed top diameter of 3 inches for pulpwood (stacked cords including bark) or 5 inches for sawlogs (International log rule with ¼-inch kerf). Pulpwood volume also includes volume shown in column headed "Sawlogs."

wildfires. With proper management, dominant and codominant longleaf may grow more rapidly than shown in the table, and, in addition, some wood will be secured from salvaging smaller trees just before they are crowded out by the dominants and codominants. The table applies to lands of average quality, where dominant longleaf trees reach a height of 70 feet at 50 years of age.

Costs and Returns

What does it cost to grow longleaf pine and what returns can be expected? Net returns will of course vary widely according to the value of the land, the tax rate, the cost of planting if planting is needed, the value of stumpage, the volume of timber produced, and even the manner in which net returns are computed. There is, therefore, no possibility of a simple precise answer to the question of net returns, but conservative estimates should show whether there is enough margin for profit to make trees a good investment.

The cash outlay for growing timber need not be large for the farmer who has only a small area, does most of the work himself, and

can get his seedlings free. On areas larger than 5 or 10 acres and where most of the labor has to be hired, the cash costs will be greater.

For example, if the owner starts with 160 acres of bare land, his initial planting costs will be about $20 an acre (at 1952 prices). This includes $4.35 for planting stock (1,450 trees at $3 per M), $6.90 for machine planting, and $8.75 for fencing. A fence is necessary where woods hogs range and is also useful where cattle grazing is combined with timber growing. The cost of fencing is estimated at $700 for each mile of fence. If areas larger than 160 acres are fenced, the cost per acre would be much lower.

Management costs will average about 55 cents per acre each year. This annual cost is for taxes, fire protection, administration, fence maintenance, marking trees for cutting, and other forestry costs.

In 25 years, the accumulated planting and management costs, without interest, will total about $33.75 per acre. The revenue from a first thinning at this time will approximately return the cost. If total sawlog yield in the next 55 years approximates that indicated on page 17, 27,000 board feet will be secured in thinnings and a final harvest cut. At $30 per thousand board feet this amounts to $810, or about $10 per acre per year for 80 years. These figures disregard interest charges, but neither do they include income from topwood, naval stores, or grazing. They do assume more or less ideal forestry conditions, so that in many circumstances the return could be much less.

MARKETING THE CROP

To insure a fair price for timber he wishes cut, the owner should:

1. Mark all timber to be cut. If cutting is to be done by the purchaser, put 2 paint spots on each tree that is to be cut, 1 below stump height for checking after cutting, and 1 several feet up the trunk for the cutters to see.

2. Make an estimate of the amount and value of the timber to be sold. If necessary, get experienced help. Ask the State forester for information and aid in marketing the timber.

3. Obtain bids for the timber from several prospective buyers. Sell to the highest bidder, but be sure he is a responsible purchaser. Sell under a sales contract or written agreement.

4. If possible, cut or harvest his own timber crop (fig. 11). Thus, along with his timber he will sell his labor and that of his teams or trucks, just as in selling his cotton or corn. Selling cut timber products in the log, pole, tie, or cord means increased money income from the forest.

Tables 3 and 4 show the approximate number of board feet and rough cords in longleaf pine trees. Table 5 gives the board-foot volumes of logs. Tables 3 and 4 assume that stumps are cut 1 foot high.

NAVAL STORES

Longleaf pine may be profitably worked for naval stores (turpentine and rosin obtained from crude gum) in combination with timber. Markets for crude gum are located mainly in the Southeast.

F–451437

FIGURE 11.—Farmers will usually earn more money from their forests if they harvest their own timber crops.

Much progress has been made in recent years in developing improved methods of turpentining. The method now recommended is acid treatment of freshly chipped streaks (fig. 12). A season's work of 16 bark streaks laid on at 2-week intervals will produce at least as much gum as 32 regular deep and untreated wood streaks laid on at 1-week intervals. A gum yield of 200 barrels per crop of 10,000 faces can be expected in a normal season. By this method, the working life of the face is almost doubled and each chipper can work nearly twice as many faces.

Streaks should be cut only deep enough to remove the inner bark and to a width of ½ to ¾ of an inch. A solution of 50 percent by weight of sulfuric acid is sprayed on the freshly cut face at the rate

TABLE 3.—*Average board-foot volume in longleaf trees of different total heights when utilized to a fixed top diameter of 5 inches inside the bark, International ¼-inch rule* [1]

Diameter breast high (inches)	Total height, feet—						
	40	50	60	70	80	90	100
	Board feet	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
6	5	11	14	19			
7	7	14	22	29	35		
8	9	20	31	42	52		
9	12	27	43	58	73	86	
10	15	36	57	77	97	115	131
11			74	100	124	147	167
12			90	121	152	180	205
13			109	146	181	214	245
14			124	166	206	244	281
15			138	184	229	272	312
16			153	205	254	302	348
17			169	226	281	332	381
18			187	248	306	360	414

[1] From *Longleaf Pine*, by W. G. Wahlenberg. P. 297. C. L. Pack Forestry Foundation, Washington, D. C. 1946.

of 1 quart of acid to 1,000 streaks. Special equipment needed is a bark hack, a plastic squeeze sprayer, and an acid-resistant cup cover. Good workmanship is needed for a profitable operation.

The producing period is generally from March to November. An advance streak is not necessary. At the end of the season, an unsprayed clean-up streak should be cut ¾ to 1 inch up to fresh tissue. The use of acid during the winter is not recommended. Tins should include 1 spiral gutter, plus 1 horizontal straight gutter for metal cups or 1 long lead gutter for flower-pot-like cups. Tins should be tacked on instead of being inserted in broadax incisions (as is done in many parts of the gum belt). Broadax incisions reduce the flow of gum as much as 35 percent during the first season's work.

Cupping should be confined to mature trees that will soon be harvested, or to trees that ought to be removed for the good of the stand. In the latter practice, called selective cupping, good trees are left to grow to large, valuable sizes while the poor trees are chipped and then cut. Such a practice will yield greater income from the stand in the long run, even though current income from gum alone may be reduced. In some areas, the black turpentine beetle kills many trees. Cupping attracts the beetles and should not be attempted where this insect is active.

Short working cycles of 5 years or less are recommended. They allow stands to be thinned at proper intervals, keep the turpentined butt in shape to be used for pulpwood or lumber, and reduce the tree deaths and the degrade associated with high faces. Worked-out

TABLE 4.—*Average rough-cord volume in longleaf trees of different total heights when utilized to a fixed top diameter of 3 inches inside the bark*[1]

Diameter breast high (inches)	Total height, feet—							
	30	40	50	60	70	80	90	100
	Cords	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*
4	0. 0107	0. 0165	0. 0220	0. 0279	-------	-------	-------	-------
5	. 0165	. 0258	. 0338	. 0413	0. 0492	-------	-------	-------
6	. 0238	. 0365	. 0490	. 0595	. 0702	0. 0841	0. 0960	-------
7	. 0320	. 0485	. 0665	. 0830	. 0960	. 110	. 125	-------
8	. 0410	. 0618	. 0865	. 107	. 126	. 140	. 158	-------
9	. 0509	. 0760	. 108	. 133	. 158	. 178	. 200	-------
10	-------	. 0915	. 129	. 163	. 194	. 223	. 247	0. 278
11	-------	-------	. 155	. 196	. 233	. 270	. 303	. 339
12	-------	-------	. 181	. 229	. 275	. 318	. 357	. 400
13	-------	-------	. 208	. 263	. 317	. 366	. 414	. 463
14	-------	-------	. 238	. 297	. 359	. 416	. 472	. 526
15	-------	-------	. 266	. 331	. 401	. 465	. 532	. 592
16	-------	-------	. 295	. 365	. 445	. 515	. 590	. 657
17	-------	-------	. 326	. 400	. 487	. 567	. 651	. 722
18	-------	-------	. 358	. 435	. 532	. 617	. 711	. 789

[1] From *Longleaf Pine*, by W. G. Wahlenberg. P. 299. C. L. Pack Forestry Foundation, Washington, D. C. 1946.

TABLE 5.—*The contents of logs in board feet by the International ¼-inch log rule*

Diameter of log at small end, inside bark (inches)	Contents when log length is—						
	8 feet	10 feet	12 feet	14 feet	16 feet	18 feet	20 feet
	Board feet	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
6	10	10	15	15	20	25	25
7	10	15	20	25	30	35	40
8	15	20	25	35	40	45	50
9	20	30	35	45	50	60	70
10	30	35	45	55	65	75	85
11	35	45	55	70	80	95	105
12	45	55	70	85	95	110	125
13	55	70	85	100	115	135	150
14	65	80	100	115	135	155	175
15	75	95	115	135	160	180	205
16	85	110	130	155	180	205	235
17	95	125	150	180	205	235	265
18	110	140	170	200	230	265	300
19	125	155	190	225	260	300	335
20	135	175	210	250	290	330	370

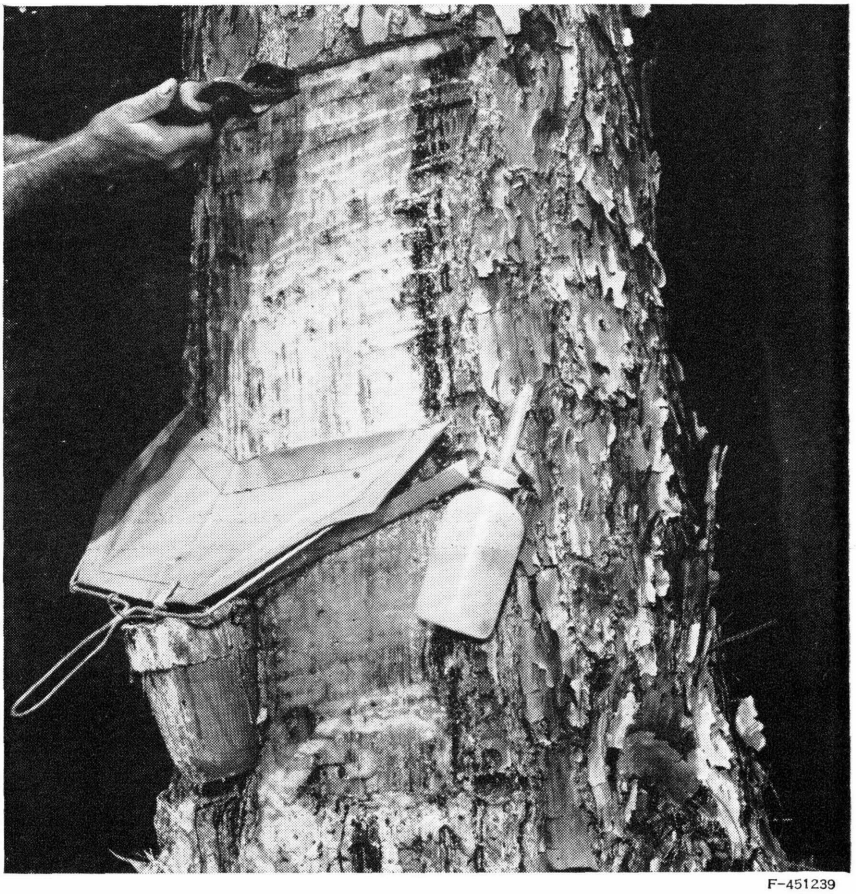

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FIGURE 12.—Sulfuric acid treatment of freshly chipped streaks is the recommended method of turpentining. Special equipment needed is a bark hack, a plastic squeeze sprayer, and an acid-resistant cup cover.

trees should be removed promptly to lessen the possibility of loss from windthrow or insects. Nails and tins should, of course, be removed first to allow the butt to be used for wood.

Naval stores producers may participate in the Naval Stores Conservation Program. This program, administered by the U. S. Forest Service for the Agricultural Conservation Programs Branch, offers a good opportunity for the producer or landowner to use good naval stores practices and to receive conservation payments for such good work. Further information may be obtained from local representatives of the program.

DUAL USE—TREES AND CATTLE

Longleaf forests usually have fewer trees and underbrush than other pine forests and therefore support more grass. This grass can be profitably grazed by cattle without harm to the timber—always

provided that cattle are excluded from stands less than 1 year old, and that grazing is thereafter moderate and combined with good range management (fig. 13). Free-range grazing, however, with its frequent and indiscriminate burning, makes forestry impossible.

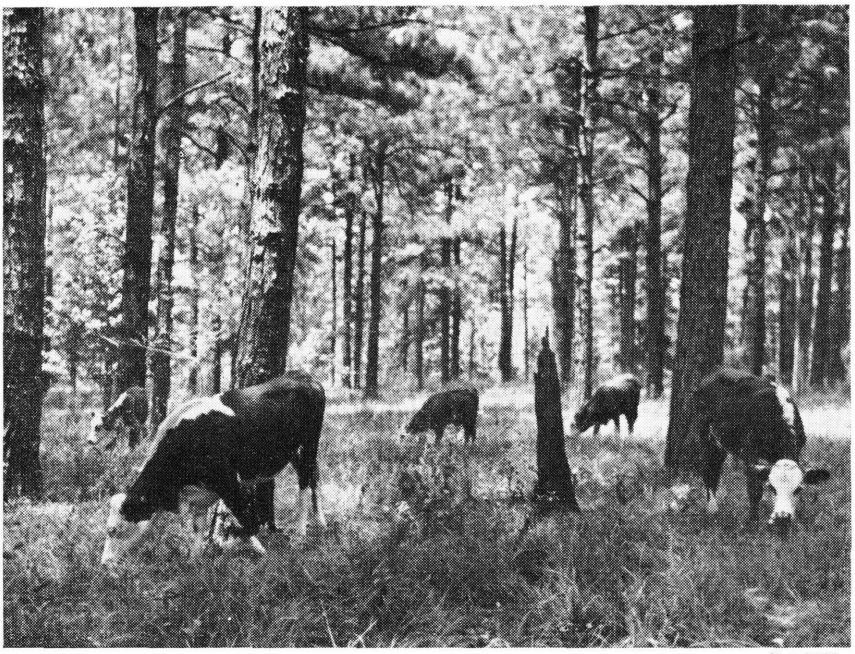

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FIGURE 13.—Longleaf forests produce abundant grass. If cattle are properly managed, they can use this forage profitably without harming timber production.

Since most longleaf pine is found in the relatively flat Coastal Plain, moderate grazing will not cause erosion or damage the watershed. Moreover, certain practices recommended for growing longleaf pine are also favorable for grazing. Periodic prescribed burning improves the forage and grazing by destroying pine needles and dead rough, thus speeding the growth of new grass and making it easily available to cattle. Likewise, moderate grazing can lessen the hazard and severity of wildfire by reducing the fuel.

Dual use of the land for timber and cattle can benefit both the farmer and the large landowner. A large landowner will realize best returns by concentrating on timber. However, he can supplement his income by a livestock enterprise. Or, if he does not want to own and raise cattle, he can receive some benefits by allowing farmers and other livestock owners the grazing privileges of his land under a lease that specifies good grazing practices. The farmer with less land can more easily grow both trees and cattle. He can carry a permanent breeding herd that can be supported partly on timberland—either his own or some that he has leased—and partly on home-grown feed and improved pastures.

Cattle numbers must be conservative to prevent damage to the seedlings and to insure that the animals get enough to eat. Since year-long grazing is usually not advisable, it is best to run stock on a basis of acres needed per cow per month. Some average acreage requirements are:

Very open, cut-over land	1 acre per cow-month
Average cut-over land	1.5 acres per cow-month
Well-stocked young stands	2.0 acres per cow-month
Well-stocked pole-size stands	3.0–5.0 acres per cow-month

As a stand grows from seedling to pole size, the amount of forage under it decreases. This decrease can be partly offset by seeding and fertilizing firebreak strips through the forest. When the trees reach sawlog size, however, the amount of forage increases considerably, so that the number of cattle can be increased accordingly. Regardless of the amount of forage, the aim should be to graze about half of each year's growth of grass.

Range forage is not an adequate year-round diet for cattle. It is best in the spring, generally from mid-March to late June, when it is abundant and nutritious. Nevertheless, too early grazing in spring, especially on freshly burned range and without other feed, may give the cows scours, cause unnecessary deaths from starvation, and lead to poor development of calves.

Range nutritive values drop in midsummer. Permanent improved pastures should be available for midsummer grazing, especially by animals to be marketed in the fall. From late fall throughout the winter, nutritional value of range forage is very low. During these months field gleanings, cover crops, improved pastures, and protein concentrates should supplement forest range.

Livestock naturally tend to overgraze in spots, particularly near water, and to leave unused forage in other areas. Proper distribution of cattle over the range is therefore essential to prevent damage to the forage and to the pine seedlings. In addition to fencing, simple remedies are to place salt on undergrazed areas of forage some distance back from water. Good distribution of grazing likewise reduces the grass rough and thereby the fire hazard.

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